

Appendix H

Exhaust Retrofit Technologies

Emission Control Devices

A. Exhaust Retrofit Technologies

As of October 2008, ARB has verified the Diesel Emission Control Strategies (DECS) shown in the tables below. The on-road devices are shown in Table 1, and the off-road devices are shown in Table 2. The proposed regulation does not accept Level 1 device for compliance purposes, so only the Verified Level 3, greater or equal to 85 percent PM reduction, and Level 2, between 50 to 84 percent PM reduction, are shown.

Additionally, passive DPF systems can increase emissions of NO₂ out of the tailpipe. To address this, the ARB verification program limits the amount of NO₂ a DECS may create and more devices may be added because of the prospect of the regulation.

Table 1: Verified On-Road DECS (as of October 2008)

Product Name	Technology Type	PM Reduction	NO _x Reduction	Applicability
Cleaire Horizon	DPF	85%	N/A	Most on-road diesel engines through 2006 model year; Certain MY 2006 and 1993 or older engines with OEM diesel oxidation catalysts; CARB diesel; biodiesel.
Cleaire Longview	Lean NO _x Catalyst and DPF	85%	25%	1993-2003 model year on-road; CARB diesel.
Donaldson DPM	DPF	85%	N/A.	1993-2004 on-road; CARB diesel; biodiesel.
Engine Control System Purifilter (Low Load)	DPF	85%	N/A	1994-2004 on-road; CARB diesel; biodiesel.
Engine Control System Purifilter (High Load)	DPF	85%	N/A	1993-2006 on-road; CARB diesel; biodiesel.
HUSS Umwelttechnik FS_MK	DPF	85%	N/A	Most on-road diesel engines through 2006 model year; CARB diesel; biodiesel.
International Truck and Engine Corporation DPX	DPF	85%	N/A.	1994-2003 on-road Navistar (International); CARB diesel.

Product Name	Technology Type	PM Reduction	NOx Reduction	Applicability
Johnson Matthey Reformulated CRT	DPF	85%	N/A.	1994-2006 on-road; CARB diesel; biodiesel.
Johnson Matthey EGRT	EGR/DPF	85%	40%	2000 International DT-466, 2000 Cummins ISM 2001, Cummins ISB, 1998-2002 Cummins ISC, 2001 Cummins ISL, 2001 MY DDC - 50, and 2001 DDC - 60 on-road; CARB diesel.
Donaldson	Flow Through Filter	50%	N/A	1991-2002 on-road; CARB diesel; biodiesel.
Environmental Solutions Worldwide Particulate Reactor	DOC	50%	N/A	Select model years 1991-1997; biodiesel.
Lubrizol PuriNOx	Emulsified Fuel	50%	15%	1988-2003 on-road.

Table 2: Verified Off-road DECS (as of October 2008)

Product Name	Technology Type	PM Reduction	NOx Reduction	Applicability
Caterpillar	DPF	85%	N/A	Conditionally verified for 1996-2008 model years; off-road, rubber tired; CARB diesel.
DCL International Inc.	DPF	85%	N/A	Conditionally verified for 1996-2008 model year, rubber tired off-road; CARB diesel.
HUSS Umwelttechnik FS_MK	DPF	85%	N/A	Most off-road diesel engines through 2006 model year; CARB diesel; biodiesel.

Product Name	Technology Type	PM Reduction	NOx Reduction	Applicability
Rypos, Inc. HDPF/C	Hybrid DPF	85%	N/A	Tier 3 off-road diesel engine standards; CARB diesel; biodiesel.
Engine Control System AZ Purifier & Purimuffler	DOC + Alt Fuel	50%	20%	1996-2002 off-road; PuriNOx.
Environmental Solutions Worldwide Particulate Reactor	DOC	50%	N/A	Select model years 1991-1997; biodiesel.

Air districts reported to ARB by August 31, 2008 deadline, and made available data on 280 on-road retrofits funded through the Carl Moyer Program from 2004 to 2008. There are 5 Medium Heavy Duty and 275 Heavy Heavy Duty. The engine model year is the replacement model year engine for the repower with retrofit activities. A reported data sample is shown in Table 3. All of the devices are verified level 3. Table 4 lists some of the Carl Moyer projects in 2004 to 2005.

Table 3: Sample of Air District Reported Data

Equipment Activity	GVWR Class	Engine Model Year	Executed Contract Date	Verify Level
retrofit	MHD	1999	2007-05-30	3

Table 4: Sample of Carl Moyer Projects for Program Year 7 (2004-05)

Air District	Carl Moyer Program Year	Grantee	Retrofit Devices	CARB VER Level	Vehicle Type	Number of Devices	Funds Applied to Device	Engine Make	Engine MY	GVWR
Sac Metro	7 (2004-05)	Sacramento Municipal Utility District	Cleaire Longview	3	Other	1	585	Caterpillar 3126	2002	29,300
Sac Metro	7 (2004-05)	Sacramento Municipal Utility District	Cleaire Longview	3	Other	1	4,600	Caterpillar 3126	1999	25,950
Sac Metro	7 (2004-05)	Sacramento Municipal Utility District	Cleaire Longview	3	Other	1	2,480	Caterpillar 3126	1999	25,950
Sac Metro	7 (2004-05)	Sacramento Municipal Utility District	Cleaire Longview	3	Other	1	2,645	Caterpillar 3126	1999	25,950
Sac Metro	7 (2004-05)	Sacramento Municipal Utility District	Cleaire Longview	3	Other	1	2,140	Caterpillar 3126	2002	35,000

Air District	Carl Moyer Program Year	Grantee	Retrofit Devices	CARB VER Level	Vehicle Type	Number of Devices	Funds Applied to Device	Engine Make	Engine MY	GVWR
Sac Metro	7 (2004-05)	Sacramento Municipal Utility District	Cleaire Longview	3	Other	1	1,550	Caterpillar 3126	1999	31,000
Sac Metro	7 (2004-05)	County of Sacramento	Cleaire Longview	3	Other	1	1,606	Caterpillar 3126	2002	35,000
Sac Metro	7 (2004-05)	County of Sacramento	Cleaire Longview	3	Other	1	2,411	Caterpillar 3126	2002	35,000
Sac Metro	7 (2004-05)	County of Sacramento	Cleaire Longview	3	Other	1	2,962	Mercedes Benz 906	2002	33,001
Sac Metro	7 (2004-05)	County of Sacramento	Cleaire Longview	3	Other	1	1,129	Caterpillar 3126	1999	35,220
Sac Metro	7 (2004-05)	County of Sacramento	Cleaire Longview	3	Other	1	1,964	Caterpillar 3126	2000	35,220
Sac Metro	7 (2004-05)	County of Sacramento	Cleaire Longview	3	Other	1	2,616	Caterpillar C12	2001	54,000
Sac Metro	7 (2004-05)	County of Sacramento	Cleaire Longview	3	Other	1	3,973	Caterpillar C12	2001	54,000
Sac Metro	7 (2004-05)	County of Sacramento	Cleaire Longview	3	Other	1	1,768	International 7.3L	2001	15,000
Sac Metro	7 (2004-05)	County of Sacramento	Cleaire Longview	3	Other	1	1,888	International 7.3L	2002	15,000

Air District	Carl Moyer Program Year	Grantee	Retrofit Devices	CARB VER Level	Vehicle Type	Number of Devices	Funds Applied to Device	Engine Make	Engine MY	GVWR
Sac Metro	7 (2004-05)	County of Sacramento	Cleaire Longview	3	Other	1	3,683	Caterpillar C10	2001	56,000
South Coast	7 (2004-05)	City of LA Environmental Affairs Dept	Johnson Matthey CCRT or CRT	3	SNG Refuse Hauler	41	8,500	Cummins L Series 8.9L	2006	51,000
South Coast	7 (2004-05)	Norwalk La Mirada USD	Cleaire Longview	3	School District Maintenance Vehicle	2	18,000	Cummins, B5.9	1998	26,000
South Coast	7 (2004-05)	Cummins Cal Pacific	Cleaire Longview	3	Transfer Truck	9	22,000	Cummins, M-11	1997	80,000
South Coast	7 (2004-05)	SSA Terminals Inc.	Donaldson DCM DOC	1	Side/Top Pick	1	3,050	Cummins QSB 5.9	2003	105,400
South Coast	7 (2004-05)	SSA Terminals Inc.	Donaldson DCM DOC	1	Side/Top Pick	4	3,050	Cummins QSM 11C	2005	185,000
Bay Area	7 (2004-05)	Waste Management, Inc	Cleaire Longview	3	Refuse Transfer Truck	10	19,000	Cummins ISM	2000	80,000
Bay Area	7 (2004-05)	FedEx Freight	Cleaire Longview	3	Delivery Truck	1	19,000	Cummins 15X	2002	80,000
Bay Area	7 (2004-05)	Blueline Transfer, Inc.	Cleaire Longview	3	Refuse Transfer Truck	1	19,000	Cummins N14	1995	38,000

Table 5 shows on-road vehicle (and equipment) or exhaust retrofit projects completed or underway worldwide. The projects are organized by geographical location, the sponsor of the project, and project timeframe. A description of each project is given (Emissions Advantage, 2005; Environment Canada, 2004; Ministry of Environment, 2004; U.S. EPA, 2005; DieselNet, 2002).

Table 5: Worldwide Retrofits Projects

LOCATION	PROGRAM SPONSOR	TIME FRAME	DESCRIPTION
Riverside, California	Ralph's Grocery / BP ARCO EC-Diesel Technology Validation	2001-2002	10 of Ralph's Class 8 Diesel Trucks retrofitted with DPFs
Los Angeles, California	Los Angeles City Sanitation Fleet/BP ARCO EC Diesel Technology Validation	2001-2002	10 Peterbilt refuse haulers and Kenworth T-800 dump trucks
San Francisco Bay Area, California	Metropolitan Transportation Commission, Bay Area Air Quality Management District	2002-2006	1,700 Diesel Transit Buses
Sacramento, California	Sacramento Metropolitan Air Quality Management District (SMAQMD), Raley's Grocery, and Sacramento Emergency Clean Air and Transportation (SECAT)	2008-	16 Class 8 Diesel Grocery Trucks retrofitted with SCRT
Seattle, Washington	City of Seattle Municipal Fleet Program	2001-2003	Heavy Duty Diesel municipal vehicles, including utility trucks and dump trucks - 215 DOCs and 10 DPFs retrofitted
Houston, Texas	Houston, TX NOx Reduction Program – Diesel Demonstration Project	2001	63 refuse trucks retrofitted with DPFs
St. Louis, Missouri	City of St. Louis/American Lung Association	2004	44 refuse trucks retrofitted with DOCs
Charlotte-Mecklenburg County, NC	Mecklenburg County Air Quality Agency/Charlotte Mecklenburg Schools	2004	58 School buses retrofitted with DOCs

LOCATION	PROGRAM SPONSOR	TIME FRAME	DESCRIPTION
Boston, Massachusetts	Boston Public Schools/Waste Management/Mystic Exelon	2004	85 Freightliner buses retrofitted with DPFs
Region of Waterloo, Canada	Public Health Department	2003-	Purchased 30 new buses equipped with DOCs and 18 new buses equipped with DPFs
Santiago, Chile	CONAMA/UN Environment Program/UN Development Program/Chile's National Petroleum Company	2004-2006	2,000 transit buses
Beijing, China	U.S. EPA/Beijing Environmental Protection Bureau (EPB)/China's State Environmental Protection Administration (SEPA)	2005-2006	25 - 30 city buses installed with emission control equipment
Seoul metropolitan region, Korea	Ministry of Environment	2004	Installation of 520 DPFs and 1,098 DOCs on government owned diesel vehicles
Stockholm, Gothenburg and Malmoe, Sweden	Cities through the Environmental Zones regulation	1996	3,000 heavy duty vehicles retrofitted with emission control systems

B. References

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